Cumulus Humilis and Virga

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An investigation was undertaken to observe and capture various cloud formations, the intent of which was to learn to identify different cloud types and to develop an understanding for cloud formation processes. A focus of this second investigation of clouds was to photograph and discuss the accessory cloud virga. The imaging technique used is presented and reviewed. The image was produced for the assignment titled *clouds2*, of the mechanical engineering course Flow Visualization[1] at the University of Colorado at Boulder. The assignment's intent is to encourage students to observe weather phenomena as embodied in the clouds, and capture them in a visually pleasing manner.

Figure 1 - Cumulus humilis in foreground, and cumulus with faint virga in lower right of frame.

In the foreground of the selected image (Figure 1) is a cumulus humilis cloud, while farther in the distance is a cumulus with faint virga below. Virga appear when a cloud forms precipitation which starts to fall, but evaporates before reaching the ground. This precipitation, which defines virga, forms soft descending streaks in the atmosphere that are often described as resembling jellyfish (Pretor-Pinney, 2007). The selected image was taken at four o'clock in the afternoon on Wednesday April 4, 2012 from behind the university recreation center. The cumulus humilis cloud was imaged facing north and is approximately 50 degrees above the horizon.

[1] The flow visualization course website can be found at: http://www.colorado.edu/MCEN/flowvis/

Discussion

The image of the clouds presented was taken the day after a small weather system. The preceding day had scattered snow flurries, but the weather cleared by April 4th. On the following days the pressure continued to drop slightly, but no storms developed (Boulder Weather History, 2012). The weather of April 4, 2012 is presented in the form of a Skew-T[2] plot in Figure 2 (UW, 2012). The temperature is typical for a winter day in Colorado (Boulder Weather History, 2012). The winds that day were steady from the south west but not strong, and calm at the surface. In the Skew-T data a CAPE value of 0 indicates a stable atmosphere, which is typical when only small and scattered cumulus clouds appear in the sky. By examining the parcel lapse rate, which indicates the cooling of a parcel of air as it is taken from the surface up into the atmosphere (Haby, 1998), no regions of instability can be identified. At low altitudes the temperature and dewpoint are close together, indicating that a small drop in temperature will cause water molecules to form water vapor (clouds). The temperature and dewpoint are closest at an elevation of 2,500m, which is likely the elevation of the cumulus clouds imaged. The presence of an inversion layer at the same elevation is an additional indication of the cloud's elevation. At higher elevations the air becomes much drier and clouds are less likely to form. Since the elevation in Boulder is about 1675m, the altitude of the clouds is estimated at 850m.

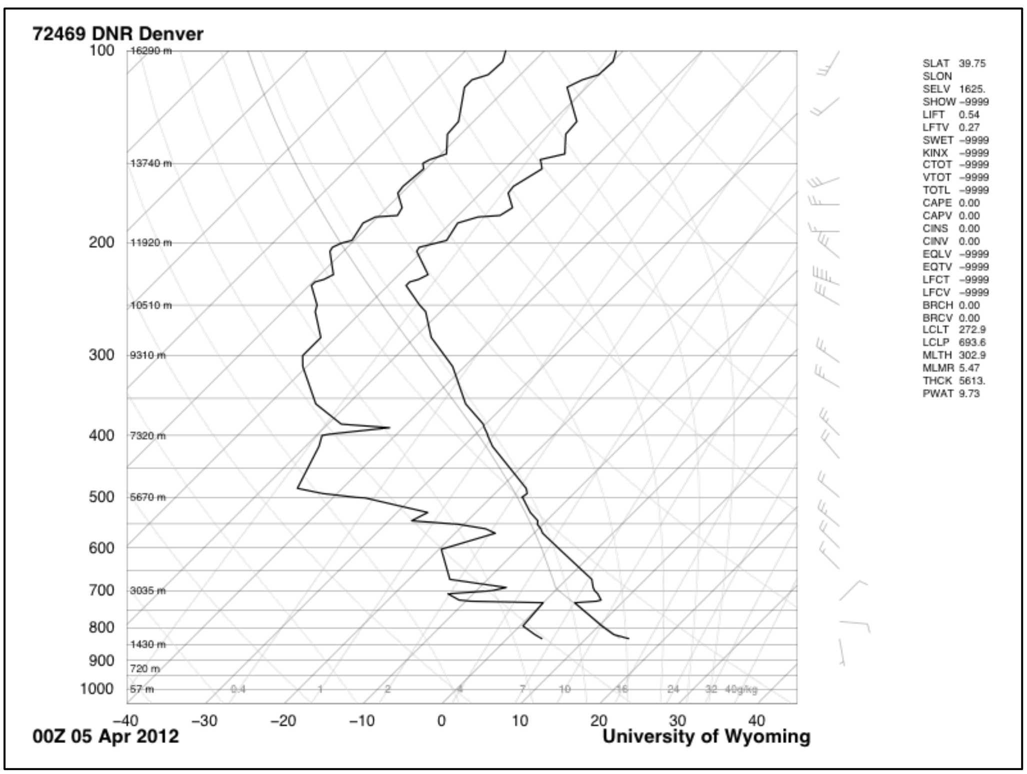

Figure 2 - Skew-T plot of the atmospheric conditions in Denver, Colorado for the evening of April 4, 2012 when the image was taken (UW, 2012). At the top of the graph, from left to right, are measurements for: the parcel lapse rate (faint grey), dew point (black), and temperature (black) .

[2] General information about Skew-T plots can be found at: http://www.theweatherprediction.com/thermo/skewt/.

The formation of a cumulus cloud is linked to thermals, or regions of hot air, that carry moist air from the planet surface up into the atmosphere. Air can be heated by the sun to rise in a column of hot air as a thermal. As the region of air rises it cools; if it cools sufficiently water vapor may condense to form a cloud. The growth of the cloud is stunted by an inversion layer. The warm air in an inversion layer can match, or be warmer than, a rising thermal, so that the air is no longer cooled to create a cloud. This formation of a cumulus cloud will occur below the inversion layer, and generally begin to wane at the inversion layer (Pretor-Pinney, 2007).

If the rising air forming a cloud is cooled sufficiently, the condensed water droplets may grow so large and heavy that they begin to fall. The cloud then begins to precipitate. However, if the surrounding air is mostly dry, the precipitation will quickly evaporate (Pretor-Pinney, 2007). The result is wispy trails of precipitation below the main cloud, known as virga. In the image presented the cumulus in the background has condensed sufficiently to begin precipitating, but the surrounding dry air causes the precipitation to evaporate, so that only fading fingers of virga are seen, rather than a sheet of rain.

Visualization Technique

The cloud was photographed using a high shutter speed and low ISO setting to capture the faint details of the virga accessory cloud. A small aperture was used to bring the cloud into sharp focus with a large depth of field. The image information and camera settings are presented in Table 1.

Table 1: Camera's Image Capture Settings	
Original Image Size	3648x2736 pixels
Final Image size	3269x2452 pixels
Resolution	240 pixels/inch
Shutter Speed	1/1000
Aperture	f/8
ISO Speed Rating	100
Focal Length	16.3 mm
Lens	6.0-42.6 mm f/2.8
Camera	Nikon P7100

The image was edited to create a warm and pleasant feel, and to provide a sense of greater detail by enhancing the contrast. The original and unedited images are appended to this document. In changing the exposure with curve adjustments some highlight detail was lost, but this accentuated the clouds against the dark sky and brought out some of the individual details of the virga. Performing selective color adjustments to create an essentially black and white image further accentuated the sky-cloud contrast. Slight cropping of the image sought an appealing composition. The final adjustment was to add some grain to the image, the intent of which was to increase the warm feeling of the image.

The final image is 3269 x 2452 pixels in size, with an angle of view (across) of roughly 65 degrees. Based on the image dimensions, and taking into account the approximate cloud altitude of 50 degrees and cloud height of 850m, the cumulus humilis cloud is estimated to be about 250m in size.

Concluding Remarks

This investigation produced an appealing photograph of the accessory cloud virga. The cloud captured is not an exemplary example, but shows the subtle way in which virga can appear. The contrast of the two cumulus clouds, the one with and the one without virga, is engaging. However, I would have preferred to capture a single more distinct instance of the virga accessory cloud, that could better be used to illustrate the process by which virga form. The image could have been improved by crisper focus, and by less hazy atmospheric conditions. In relation to the captured image, the formation of a cumulus humilis cloud was discussed along with the link between precipitation and virga. The accessory cloud virga is beautiful and interesting in it's ephemeral nature, and the topic could be investigated further by monitoring cumulus clouds and observing how virga form and dissipate.

References

Boulder Weather History. (2012, April 17). Retrieved April 17, 2012, from Weather Spark: http://weatherspark.com/#!graphs;a=USA/CO/Boulder

Haby, J. (1998). *Skew-T Basics*. Retrieved April 17, 2012, from theweatherprediction.com: http://www.theweatherprediction.com/thermo/skewt/

Pretor-Pinney, G. (2007). *the Cloudspotter's Guide.* New York, NY: Perigree Trade.

UW. (2012, 02 15). *University of Wyoming Atmospheric Sounding data*. Retrieved 02 25, 2012, from http://weather.uwyo.edu/upperair/sounding.html

Original, as shot, image of cumulus humilis and cumulus humilis with virga.

Edited Image: exposure decreased to bring in highlights; contrast increased; grain added to achieve desired aesthetic.